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PRELIMINARY INVESTIGATION OF WASTE DISPOSAL IN THE NEW YORK BIGHT

NORTHEAST MARINE HEALTH SCIENCES LABORATORY

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BUREAU OF DISEASE PREVENTION AND ENVIRONMENTAL CONTROL

National Center for Urban and Industrial Health

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PRELIMINARY INVESTIGATION OF WASTE DISPOSAL IN THE NEW YORK BIGHT

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by

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INTRODUCTION

Requests by Region II, Water Supply and Sea Resources Program, coupled with those of state, and industry interested in shellfish sanitation and production were responsible for NEMHSL, FRD Section, undertaking an investigation of the waters of the New York Bight utilized as a sewage sludge disposal grounds for much of the New York Metropolitan Area. At the 1962 Region II Shellfish Sanitation Conference it was recommended that the "Public Health Service be the responsible agency in the cooperative interstate shellfish shipper program for the classification of sea clam areas beyond the territorial limits of the states." The sea clam, Spisula solidissima, referred to as the surf clam in most resource studies, exists in commercially important populations on the continental shell adjacent to the states of New Jersey, Delaware and Maryland. The classification of surf clam growing areas by the "Public Health Service" was discussed at the 1963, 1964, and 1965 Region II Shellfish Sanitation Conferences. Preliminary plans to attack this problem were drafted in 1963 and in 1964 NEMHSL conducted preliminary studies on surf clam bacteriological sampling techniques, etc. in conjunction with the New York State Conservation Laboratory, Oakdale, Long Island, New York. These studies were in preparation for the surf clam growing area studies whenever they could be undertaken.

The role of a health agency is to prevent bacterial, virological, chemical, and toxicological contaminated shellfish and other marine food products from reaching the consumer. When shellfish producing areas are adjacent to known pollution sources, adequate closure lines must be established to prevent harvesting of potentially unsafe shellfish. Commercially important surf clam beds are found to the south of the New York Bight waste disposal area. The surf clam resource areas are shown on Figure 1 (Bureau of Commercial Fisheries, 1966). The disposal area investigated is shown on Figure 2.

According to records of the Supervisor of New York Harbor, U.S. Army Engineers, there are seventeen loading points for sewage sludge to be hauled to sea in the New York City -- New Jersey Metropolitan Area.

Four of the seventeen loading points are in New Jersey and the others in New York. The total sludge volume for the year 1964-1965 was 3,965,876 cu.yds. or an average of 10,865 cu.yds. per day. An additional 1,800 cu.yds. per day is expected from the recently completed Newtown Creek Plant which will also raise the number of loading points to eighteen. Table A-1 lists the treatment plants along with their capacity, type of treatment and date of construction. Table A-2 presents monthly quantities of sludge from each plant. The digested or partially digested sludge is hauled by barge or tanker to a disposal area described by the U.S. Army Engineers as follows:

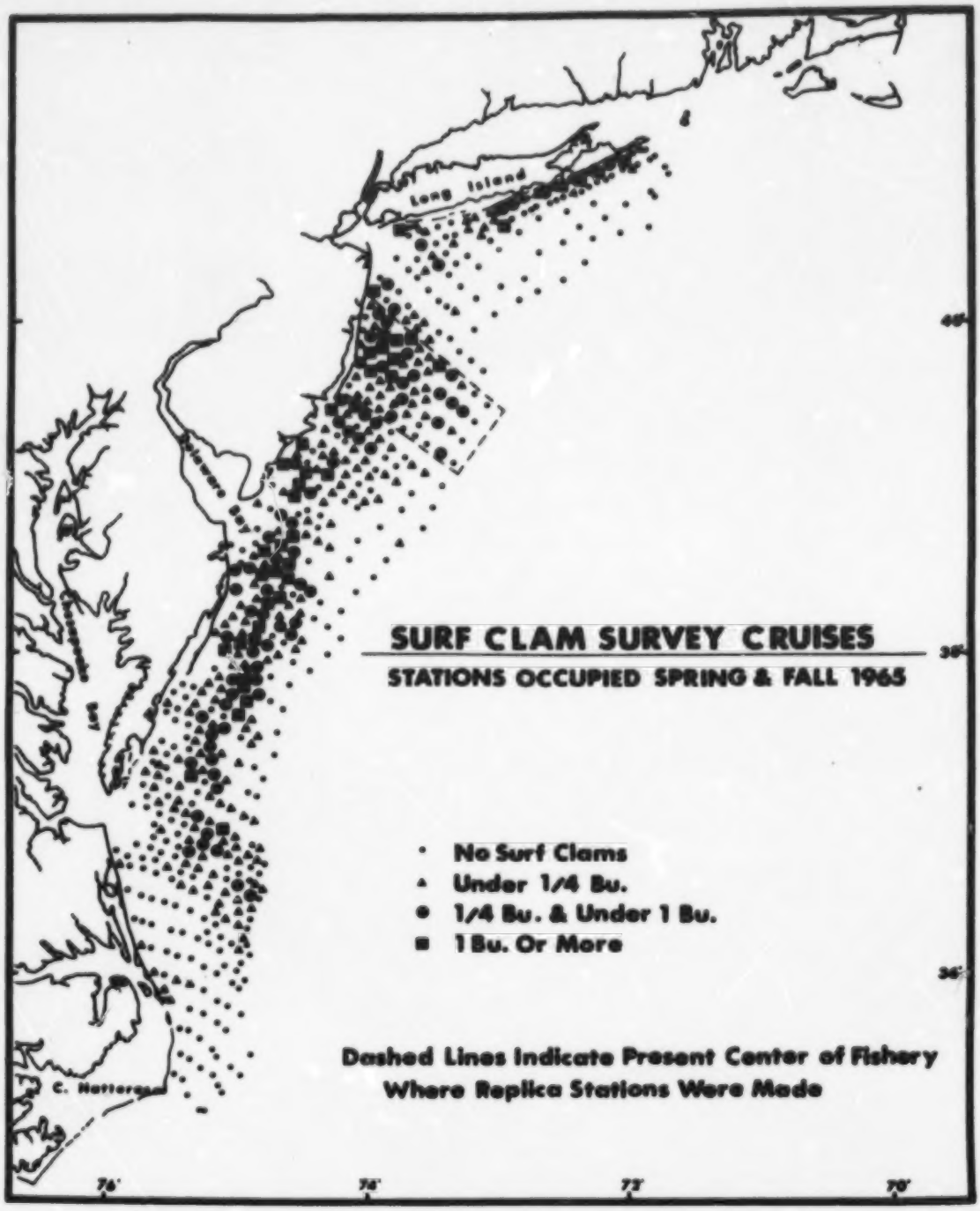
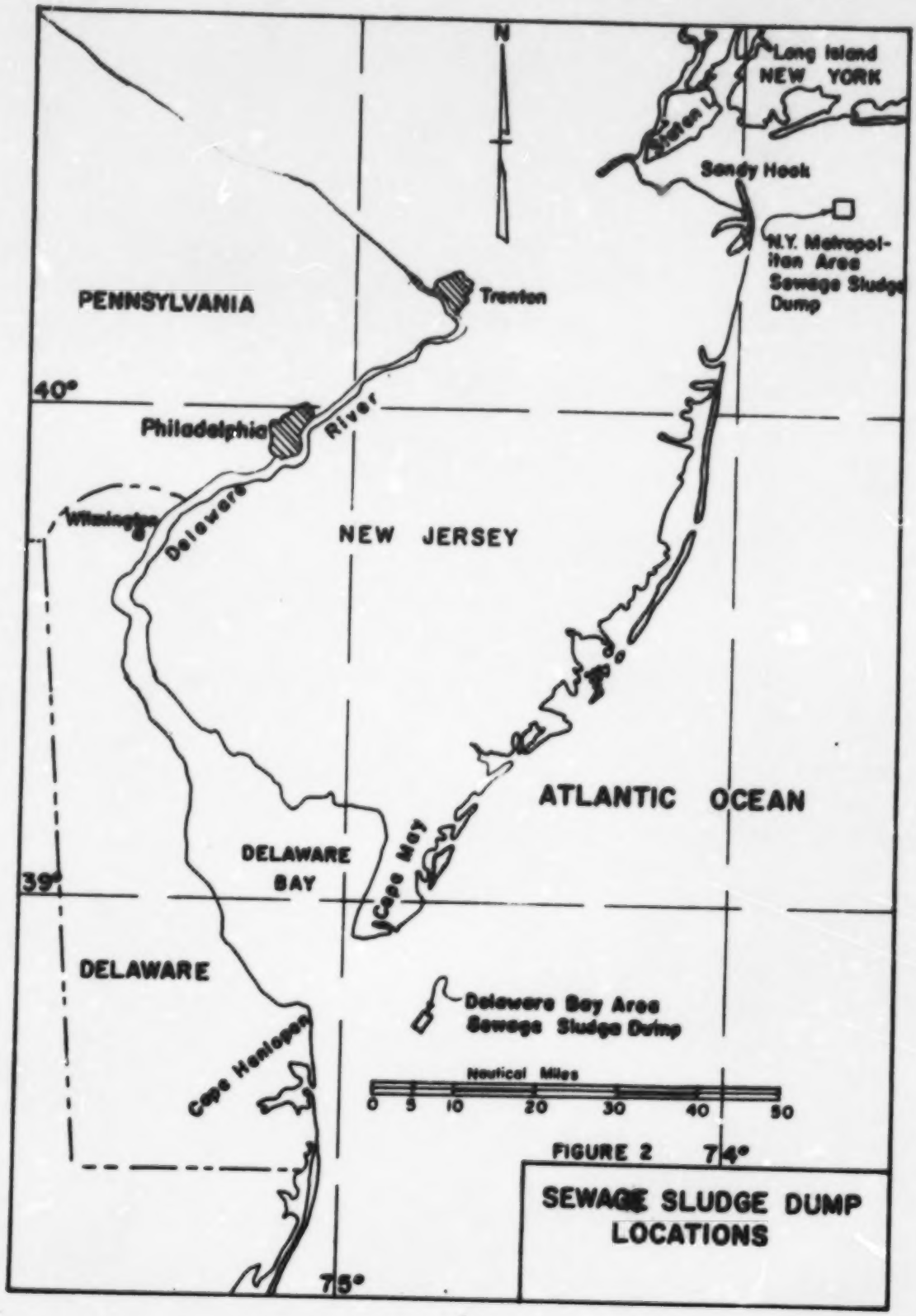


FIGURE 1

(Taken from the United States Bureau of Commercial Fisheries Biological Laboratory, Oxford, Maryland, Technical Report, Progress in Surf Clam Biological Research, June 1966.)


N
Long Island
NEW YORK
Staten I.
Sandy Hook
N.Y. Metropol-
itan Area
Sewage Sludge
Dump
PENNSYLVANIA
Trenton
40°
Philadelphia
River
Delaware
Wilmington
NEW JERSEY
ATLANTIC OCEAN
DELAWARE
BAY
Cape May
39°
DELAWARE
Delaware Bay Area
Sewage Sludge Dump
Cape Henlopen
Nautical Miles
0 5 10 20 30 40 50
FIGURE 2
74°
SEWAGE SLUDGE DUMP
LOCATIONS
75°

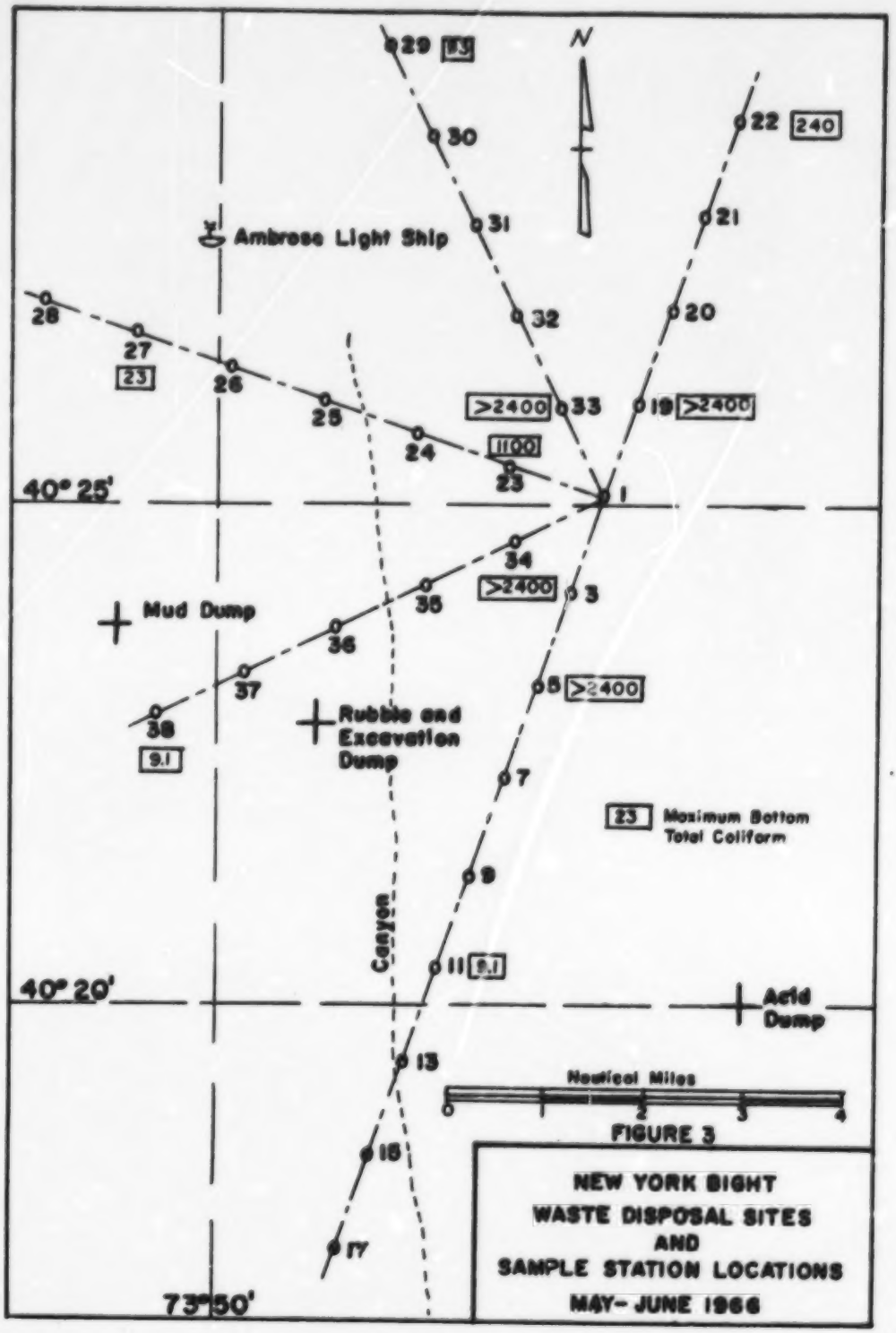


FIGURE 3

NEW YORK BIGHT
WASTE DISPOSAL SITES
AND
SAMPLE STATION LOCATIONS
MAY- JUNE 1966

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"Commence dumping at a point not less than 11 nautical miles bearing 103° (True) from Sandy Hook Light at latitude 40° 25' 04" North and longitude 73° 44' 53" West; proceed on a southeasterly course and there deposit it in not less than 72 feet of water."

The described point is at Station 1 on Figure 3. See the Appendix for further information on dumping regulations.

The sewage sludge contains some of the pathogenic organisms found in the raw sewage. The concentration depends upon the length of digestion time, the supply of food, the number of competitive organisms and other environmental conditions.

Treatment of sewage by various methods will reduce the numbers of pathogenic enteric bacteria, virus, and tubercle bacilli but the treated waste will contain some of each kind of microorganism found in the raw sewage (Rebler, 1959). The difficulty here is the determination of the pathogen concentrations for different digestion periods and conditions; for example, each source may have sludge of different quality.

The barges or tankers disposing of sewage sludge in the New York Bight take from 1½ to 3½ hours travel time to reach the dump site. The time of departure schedule of the vessels and quantity of sludge hauled to the New York Bight during the time of the investigation is presented in Table 1.

The sewage sludge waste discharged is done in the same manner as the procedure given for disposal of acid wastes as found in the Appendix. The vessel proceeds at the greatest speed practicable while discharging the waste. The turbulence created by the propellers and the wake of the vessel aid greatly in rapid mixing and dilution with the sea water. When at least half of the load is discharged the vessel makes a wide U-turn and runs a return course parallel to the outgoing one until discharge is completed.

This preliminary investigation of the New York Bight Waste Disposal Area is considered the first phase of the offshore water quality program of NEHISL, WSSRP, USPHS. The primary objective was to acquire some data on bacterial distribution resulting from the discharged sewage sludge. It was also felt that the study would provide assistance in planning future studies of dispersion and effects of waste discharges at sea. This study was also to serve as an opportunity to try out various sampling devices in deep water.

The research vessel, Challenger, was chartered from the Sandy Hook Marine Laboratory, Bureau of Sport Fisheries and Wildlife, Sandy Hook, New Jersey for sample collection operations. The laboratory work was done in the NEHISL, FPD mobile laboratory at the Sandy Hook Station.

TABLE 1

SLUDGE DUMPING SCHEDULE*
NEW YORK BIGHT AREA
MAY 1 - 10, 1966

Date	Departure Time	Quantity Dumped (cubic yards)
5/1/66	1500	7800
5/2/66	0740	2480
	0751	2024
	0820	2024
	1400	2024
	1630	7800
5/3/66	0740	2480
	1530	2480
	1610	2024
5/4/66	0300	7800
	0752	2024
	1535	2480
	1615	2024
5/5/66	0830	2024
	1400	2024
	1530	2480
5/6/66	0743	2480
	0822	2024
	1550	2024
	1600	2480
5/7/66	0300	2370
	0745	2480
	1410	7800
5/8/66	1530	7800
5/9/66	0825	2480
	0830	2024
	0900	2024
5/10/66	0745	2480
	0810	2024
	0820	2024
	1547	2024
	1549	2480
	2000	7800
	TOTAL Cubic Yards	105,810

*Provided by the New York District Office, U.S. Army Engineers

PROCEDURES

Sampling stations were set up at one mile intervals along a base line running northeasterly and southwesterly directions (20°-200°) from the point beyond which sewage sludge can be discharged. Three additional transects were established west of this base line at azimuths of 245°, 290° and 335° using the point for beginning of discharge as the vertex. Figure 3 shows the location of the sampling stations.

Surface, mid-depth and approximately 0.5 meter from the bottom water samples were collected at each of the stations. Water samples were taken twice at most of the sampling stations. The water samples were iced until they could be set up on shore. Total coliform and fecal coliform determinations were conducted according to APHA recommended procedures. Salinities, temperatures and depths were recorded for each water sample collected. Bottom core sampling was done with a Phleger corer.

Dredging for shellfish produced no surf clams because bottom conditions were not favorable with mud, sludge and debris covering most of the area. A few black quahogs were caught on two of the drags.

Sewage sludge samples from the holding tanks of three sewage treatment plants were examined for coliform population density.

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BACTERIOLOGICAL RESULTS

Examination of Sewage Sludge

The samples of stored sewage sludge collected at three of the treatment plants using the New York Bight for a disposal ground were analyzed for coliform organisms. The results are listed in Table 2.

TABLE 2

COLIFORM MPN's PER 100 ML IN STORED SLUDGE TO BE DISPOSED OF IN THE NEW YORK BIGHT

Sample No.	Date of Sample	Coliform MPN per 100 ml	
		Total	Fecal
1	May 11, 1966	$>2.4 \times 10^9$	43×10^6
2	May 11, 1966	$>2.4 \times 10^9$	$>2.4 \times 10^9$
3	May 11, 1966	4.3×10^6	4.3×10^5

These results point out the variability found in the sewage sludge. All samples showed high coliform populations which implies that high pathogenic populations can exist in the sludge being disposed of at sea.

Surface Sample Following Discharge

A sample was collected immediately after discharge from a vessel took place. It was taken on May 3 at 1115 and resulted in MPN values in excess of 2,400,000 per 100 ml for both total and fecal coliforms. Another sample was taken May 5 at 1045 on the outer edge of a dispersed discharge of sludge a few minutes after discharge took place (estimate 4 to 8 minutes). The sample produced MPN values of 460,000 total and 240,000 fecal coliforms per 100 ml. The indicating coliforms are present in large numbers at the time of the sludge discharge.

Water Quality

The complete bacteriological determinations have been placed in Table A-2 in the Appendix. The maximum total coliform counts in bottom samples for points near the vertex and toward the end of the sampling rays are indicated on Figure 3. The counts at five miles or greater from Station 1, the point where discharge was to begin, were greatly diminished. The vessels observed discharging were all in the general designated disposal area but covered a range of at least two miles north or south of Station 1. It is easy to visualize discharges either short of or beyond the designated point without stationary markers indicating the point to begin discharge.

Where shellfish sanitation is concerned the mile or two discrepancy would be important.

Samples were not collected east of Station 1 because of time limitations of the study. Since the discharges are to be made while moving in a southeasterly direction high counts would be expected at distances of greater than five miles east and southeast of Station 1.

High counts to the north of Station 1 indicate that discharges take place north of this point. Bottom samples at Station 32 and 33, the only high results on May 8, indicate this (See Table 3). The high counts found all along the sample leg Station 19-22 on May 6 are attributed to discharges being north of the target area, one of which was observed during the sample run. The results at Station 26 and 28 on May 6 indicate some discharge by either a sludge hauling vessel or some other source having occurred out of the designated disposal area. The five mile distance from Station 1 needed to reduce the coliform concentrations appears caused to a great degree by the occurrence of discharges outside of the designated area. Without better control of the discharges this cannot be proven. It would be erroneous to consider anything less than six miles from the point of a sewage sludge discharge as safe from bacterial contamination under the conditions existing during this investigation. This is not to be taken as six miles from Station 1 because as previously explained disposal does not always take place in the designated dump area.

Except when sampling closely followed a sludge discharge in the area being sampled the higher coliform determinations were found in the bottom water samples. The MPN values found to be greater than 100 per 100 ml for total coliform are arranged in Table 3. The two high count surface samples at Station 5 on May 2 and 3 were both influenced by a sludge discharge during the time of sampling. The majority of the sludge appeared to settle rapidly after discharge as observed from the deck of the Challenger. A small portion of the discharged material remained on the surface in a visible pattern for at least two hours when the seas were relatively quiet.

The 25 samples in Table 3, consisting of 16 bottom, 7 surface and only 2 mid-depth lend support to the visual observation that the major sludge components are either rapid-settling or floating. The results in Table 3 also indicate that coliforms can survive for a time when concentrated on the bottom. The samples at Station 32 and 33, May 8, give such an indication with total coliforms of >2,400 per 100 ml in the bottom samples. According to the sludge dump schedule, Table 1, the last discharge prior to sample collecting should have occurred by 1730 on May 7. This would mean a time elapse of about 16 hours between the last reported discharge and sample collection on May 8 at 0930. The quantity of sludge discharged was large and this could have some bearing on the high counts. The dump was not observed so it may have occurred at a later time.

The rapid reduction of coliforms indicated by the results of this investigation can best be explained by a combination of dilution with the receiving sea water and die off due to the disinfecting power of the sea water column. That higher concentrations of sludge settled in unsampled places cannot be eliminated by the findings of such a limited study.

TABLE 3

TOTAL COLIFORM MPN's >100 PER 100 ML SAMPLES IN NEW YORK BIGHT

Station	Date May 1966	Time EDST	Total Coliform MPN per 100 ml Surface	Mid-depth	Bottom
1	2	1100			240
3	3	1105			>2,400
5	2	1220	11,000		
5	3	1125	>2,400	1,100	>2,400
7	3	1140	460		
19	6	1055		460	>2,400
20	6	1040	150		460
21	6	1025			240
22	6	1005			240
23	6	1115			1,100
24	6	1125			1,100
25	6	1140			210
26	6	1150	150		460
28	6	1220	460		
31	7	1003			460
32	8	0917			>2,400
33	8	0930			>2,400
34	7	1057			>2,400
35	7	1105	210		240

The seemingly low coliform resuts obtained from the first days of sampling raised the question of possible die off between collection time and set up time on shore. Duplicate testing was initiated to answer this question. The surface samples taken on May 5-7 were set up on the Challenger immediately after collection and a split sample was set up in the mobile laboratory after the days sampling was completed. The results contained in Table A-4 plainly show that icing and holding the samples has little or no significant effect on coliform determinations.

Shellfish

One black quahog sample suitable for bacteriological examination was obtained during the day spent dredging for shellfish. It was from the vicinity of Station 20. The examination of this sample resulted in coliform MPN values of 490 total and 78 fecal per 100 ml.

Hydrographic Considerations

The only hydrographic measurements made in the dump region during this investigation were routine temperature and salinity. However, several comprehensive studies were conducted in the region in far greater detail than could have been accomplished during this preliminary study.

Studies by Redfield, 1951; Miller, 1952; Howe, 1962 and Bumpus, 1965 provide an invaluable store of data on the area under consideration. The generalized surface flow during the month of May is south and shoreward. There is some indication from the data by Bumpus (1965), that a surface drift may head toward the western tip of Long Island or perhaps toward Raritan Bay. Although Howe (1962), did not conduct spring studies, he did measure velocities at depth. Velocities adjacent to the New York Bight are shown in Table 4.

TABLE 4

CURRENTS NEAR NEW YORK HARBOR*

Depth (meters)	Velocity (cms)	Date
9	8.5	July - August 1961
25	4.0	July - August 1961
10	6.8	November 1961
30	4.5	November 1961

*After Howe (1962).

The velocities are about one-half the observed nontidal drift velocities shown by Redfield (1951) for the Scotland Lightship area. The at depth velocities shown by Howe (1962), correspond well with Redfield's studies and the differences are small considering the extreme variability of conditions that can occur.

Standard salinity and temperature measurements were made during all runs, see Table A-5. There is little evidence to indicate that stratification was of any consequence in the dump area during the time of the study. Temperatures rarely varied more than two degrees in up to 150 feet of water and salinities normally varied less than 2‰. On May 2 wind speeds dropped to less than one knot and conditions remained very uniform throughout the day. May 3, 5, and 6 had winds generally over 15 knots. The early morning period of May 7 had gusty winds to 18 knots which decreased to 7 knots by 1130 EDST. Early morning winds gusted to 18 knots but diminished to 2 knots by 1040. The variety of wind conditions encountered did not produce any unusual changes in temperature or salinity. The lowest salinities found were the surface samples nearest New York Harbor (Station 27 and 28) as could be expected.

Bottom Deposits

Several factors affect the behavior of a waste discharged at sea. The sludge waste studied in this report does not contain excessive oil or floatables (i.e. garbage that are likely to act as a coherent mass or drift toward the shore on the surface. The material normally settles and accumulates on the bottom. Some of the fine suspended particles will remain in suspension for long periods of time. Based on surface drift observations by Redfield (1951), it can be assumed that approximately ten percent of the movement of the surface materials will be toward the shore. The bottom accumulation is another problem. The dump site is very close to the head of the Hudson Canyon. Although only eleven bottom core samples were taken, there is some evidence to indicate a southerly drift. Disposal into the head of the canyon may appear to be a solution, but biological considerations may be more important. Some evidence exists to indicate the presence of large populations of lobster and red crab in the lower parts of the canyon. The breeding zone, however, is apparently in the shallow upper reaches of the canyon. Long-term dumping in the present location may endanger this entire marine population and food resource. Table 5 shows the Stations, descriptive identification and penetrations for the bottom cores.

TABLE 5

BOTTOM CORES

Sta.	Water Depth (ft.)	Depth of Penetrations (inches)	Description
1	80	12	Dense, gray and black sand, sludge
5	85	12	Sludge
9	100	15	Sludge
13	150	12	Sludge, gray sand with yellow -- brown sand below
20	90	12	--------
22	80		No sample - hard bottom - no sludge
24	106	12	Very thin material - sludge
26	85	30	Mud - sludge
28	75	16	Light sand
30	85	-	Fine yellow sand
32	93	-	No indication of penetration

Sand and mud are dispersed and widespread over the entire area, with varying types of gray, brown and yellow sands. The sludge imparts a black coloration, due to deterioration, as well as an odor, in some cases to the overlying bottom materials.

One core sample made near Station 37 gave an indication of mud depths of at least 5 feet. This was in the mud dump and rubble-excavation dump area. A clam dredge drag near Station 20 picked up black, sandy mud and much debris such as broken glass. A clam dredge drag near Station 37 recovered a load of mud, rubble and metal trash. Adequate studies of bottom sediments in the disposal areas have not been done. A bottom sampling study should be undertaken to fulfill this need.

Discussion

Little attention has been given to the effects of waste disposal on marine organisms. Conferences have been concerned with the visual effects, dangers to beaches, sport fishing and adequate dispersal of pollutants but not with the environment. Additional current studies of a preliminary nature are not warranted in the light of the more intensive work that has been conducted in the past few years. Long-term detailed analysis of sludge drift and bottom currents are needed in the entire region as well as environmental information of the bottom organisms.

Acid Waste Dump

The sulfuric acid and ferrous sulfide waste discharged in the New York Bight by National Lead Company was a continuing item of discussion at the annual meetings of the Middle Atlantic Section of the Atlantic States Marine Fisheries Commission in the late 1940's and through the 1950's Sportsman's groups were also actively concerned with this waste discharge.

The acid dump waste is said to consist in part of: 9% dilute H_2SO_4, 7% $FeSO_4$ and 25% inert solids. The waste is hauled in a barge with rubber lined tanks. The barge is 286 feet long, 52 feet wide and has a draft of 17 feet. There are 8 acid tanks and 2 mud tanks on the barge. The barge averages about 1.6 trips per day. The location of the acid dump is shown on Figure 3. On the southwest sample run, Station 1 to 17 a large patch of light yellowish green water was encountered between Station 9 and 11. There was a very definite line of demarcation between the light green patch and the usual dark green water of the ocean. The light green color was said to be caused by the disposal of waste acids according to the crew of the Challenger. The clear dividing line of colors suggests an interface exists between the acid waste mixed with the initial dilution sea water and the surrounding sea.

The crew on the Challenger stated that this acid waste was not only contained by vertical boundaries but also by a horizontal one at a depth of 30 to 50 feet. The acid dump patch extended for several miles. The effects of this acid waste dumping have been studied (Redfield, 1951). That study determined that the acid-iron waste when discharged to the sea was rapidly diluted and the acidity neutralized; that the chemical properties of the receiving water would not be expected to be changed to any great distance or depth from the discharge point; that there were no observable damaging effects on the populations of fish or bottom animals in the discharge area and that no bottom accumulations had resulted during the relatively short period that disposal had been practiced. Recommendations were made for investigating each type of waste individually and continued monitoring for long-term effect and increased discharges (Redfield, 1951).

An "Unpublished Manuscript," Report 57-5 by Woods Hole Oceanographic Institute reported that analysis of sediment samples from the disposal area during 1956 showed no cumulative change in iron content during the years of dumping since 1948.

Chemical Analysis

Four one gallon samples of sea water were taken from various depths in the area colored by the acid waste discharges. The samples were taken at a point midway between Station 5 and 7. They were analyzed for organic and inorganic components. A "baseline" sample taken from Narragansett Bay was analyzed along with them. In addition, three mud cores and two samples of black quahogs were analyzed.

The water samples were run over 500 ml of activated charcoal to trap the organics. The inorganic material remains in the eluate. Subsequently the charcoal columns were extracted with 99.5% ethanol, chloroform and ether to be tested for organic groups.

The mud samples were mixed with a 300 ml volume of distilled water and the supernatant treated in the same manner as the sea water samples. Three such extractions were performed and the extracts combined and made up to one liter.

The two black quahog samples were shucked, homogenized and freeze-dried in the standard manner and analyzed for trace metal content.

Summary of Findings

The inorganic ion determinations of the sea water samples are presented in Table 6. Nothing significant appears in these values.

TABLE 6

INORGANIC IONS -- SEA WATER SAMPLES

Samples collected in acid dump area between Sta. 5 and 7 on May 22, 1966

Depth of Sample	pH	Sulfate (SO_4) (gm/liter)	Chloride (gm/liter)
Surface	8.3	1.402	10.59
20 feet	8.4	1.392	10.35
30 feet	8.5	1.497	11.07
Bottom 100 feet	84	1.528	11.27
Baseline Sample taken 2-3-67 from Narragansett Bay. Temp. 20°C	8.33	1.671	16.74

The more obvious organic compounds to be found in various industrial chemical wastes are represented by the group types of organic compounds indicated in Table 7.

TABLE 7

ORGANIC GROUPS IDENTIFIED IN THE ETHANOL EXTRACT IN SEA WATER AND MUD SAMPLES

(Feigl spot tests employed)

Sample	Amino	Org. Sulfide	Aromatic	Nitro	Nitroso	Carboxy Acid	Phenol
1. Surface Water	✓	-	✓	✓	-	-	✓
2. 20' depth water	✓	-	✓	✓	-	-	✓
3. 30' depth water	✓	-	✓	✓	-	-	✓
4. Bottom depth water	very marginal	-	✓	✓	-	-	very marginal
Narr. Bay	✓	-	✓	✓	-	-	✓
Sta. 24 mud	✓	-	✓	✓	-	-	✓
Sta. 26 mud	✓	-	✓	✓	-	-	✓
Sta. 28 mud	✓	-	✓	-	-	-	✓

Note: ✓ = present in sufficient quantity for detection
- = absent or insufficient quantity for detection

Ether and chloform extracts yielded a very slight film and may be examined later together with a hexane extract.

The sea water trace metal values shown in Table 8 are about as expected with the exception of copper. The average copper level for Narragansett Bay is approximately 0.03 ppm. The value found in the New York Bight sample represents a water value approximately 4,000 times that of Narragansett Bay. One is hard pressed to offer an explanation for this elevated level. This could well be a passing incidence of pollution. A number of continuous samples would furnish an answer.

TABLE 8

TRACE METALS IN SEA WATER SAMPLES

Sample Depth	Trace Metal Expressed as mg/liter								
	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Surface	0	0	0	119.9	0	0	0	0	0
20'	0	0	0	122.4	0	0	0	0	0
30'	0	0	0	133.4	0	0	0	0	0
Bottom 100'	0	0	0	131.0	0	0	0	0	0
Narragansett Bay	0.032	0.191	<0.2	0.034	0.141	0.054	0.225	0.375	0.015

The zero values in the above Table represent values somewhat less than those found in Narragansett Bay and agree substantially with published values as given in the following Table 9.

TABLE 9

AVERAGE TRACE METAL LEVELS FOUND IN SEA WATER FREE OF POLLUTION

Trace Metals in ppm								
Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
0.00011	0.00027	0.00005	0.003	Soluble 0.0026 Total 0.0062	0.002	0.0054	0.00003	0.01

Trace metal values for the core samples at the three stations given in Table 10 represent nothing significant with the exception of the higher concentrations found for Station 24.

The trace metal concentrations in the black quahog samples given in Table 11 show apparent normal values in the case of zinc, nickle, copper and cobalt (Zn 20-40 ppm; Ni <0.20 ppm; Cu 1-7 ppm; Co <0.20 ppm). The value for cadmium is not significantly elevated (usually <0.10 ppm). However, the values shown for chromium and manganese appear to be in excess of those normally found for the quahog (Cr <0.20 ppm; Mn 3-7 ppm). The tissue levels in the case of iron and lead are very significantly elevated beyond that found as a normal base line (Fe 50-70 ppm; Pb <0.15 ppm).

TABLE 10

TRACE METALS IN MUD CORE SAMPLES

Sample Station	Trace Metal (mg/l)		
	Cu	Fe	Zn
24	0.495	6.20	2.09
26	0.12	0.74	0.16
28	0.16	0.214	0.163

Cd, Co, Cr, Mn, Ni and Pb were absent or in quantities below the detectable limits for the method used.

TABLE 11

TRACE METALS IN BLACK QUAHOG SAMPLES

Expressed as mg/kilo drained wet weight

Sample	Trace Metals (mg/kilo)								
	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Sta. 20 (7 quahogs)	0.138	<0.20	0.19	2.44	426.0	-	<0.20	4.61	12.70
Sta. 27 (3 quahogs)	0.24	<0.20	5.78	4.68	1,331.0	22.40	<0.20	7.50	23.61

Recommendations

1. An area of six miles in radius from any point at which a sewage sludge waste discharge takes place should be classified off limits or prohibited to shellfishing. Such an area would permit adequate dispersion, alteration and dilution of contaminated material under conditions existing during the time of the study. This would easily cover distances greater than ten miles from the point designated for beginning of discharge

2. The dump areas should be adequately marked to assure deposition in the designated region. Safeguards by means of surveillance should be established.

3. A survey of the extent of the sludge dispersion and depth of the deposit should be made.

4. Bottom currents in the dump area should be measured over a sufficient period of time to establish normal drift patterns of the bottom sediments. Four one month periods over a year may be adequate.

5. The survival of sewage sludge induced organisms in the bottom sediments of the dump area should be investigated.

6. Additional chemical analysis should be done on water, shellfish and sediment in the dump area. The limited samples taken on this preliminary study are of value mainly to show where any future work should be directed.

7. No relocation of the dump areas could be justifiably recommended from the limited results obtained from the preliminary type of investigation undertaken. The bottom in the area of the mud, rubble-excavation and sewage sludge dump is so badly fouled that changing of dump locations would be of little help to this immediate area. However, consideration must be given to the possibility of these deposits, from long-term dumping, drifting into the Hudson Canyon and causing harm to certain marine populations.

APPENDIX

Dumping Regulations - U.S. Army Engineer District New York (NADNY Form 23, 20 April 1965)

The U.S. Army Engineer District New York Supervisor New York Harbor issues permits for disposal of wastes at sea. The permit form, NADNY Form 23, 20 April 1965, contains the following regulatory statement:

> "Under provisions of Section 3 of the River and Harbor Act of 29 June 1888, as amended 18 August 1894, and 28 May 1908, (33 U. S. C. Sec. 443), you are authorized by the Supervisor of New York Harbor to tow and dispose of the material noted below by the following vessels, in accordance with the regulations and special conditions noted herein. YOUR FAILURE TO COMPLY WITH ANY OF THE REGULATIONS AND CONDITIONS MAY BE JUSTIFICATION FOR REFUSING FUTURE PERMITS."

The waste disposal areas in the New York Bight are described on the permit as follows:

1. Sewage Sludge

   "Commence dumping at a point not less than 11 nautical miles bearing 103° (True) from Sandy Hook Light; at latitude 40° 25' 04" North and longitude 73° 44' 53" West; proceed on a southeasterly course and there deposit it in not less than 72 feet of water."

2. Mud

   "Located at a point not less than 7 nautical miles bearing 120° (True) from Sandy Hook Light; at latitude 40° 23' 48" North and longitude 73° 51' 21" West, and there deposit it in not less than 60 feet of water."

3. Rubble and Excavation

   "Located at a point not less than 9 nautical miles bearing 118° 30' (True) from Sandy Hook Light; at latitude 40° 22' 53" North and longitude 73° 48' 40" West, and there deposit it in not less than 90 feet of water."

4. Acid Waste

   "Commence discharge in area SOUTH of Latitude 40° 20' NORTH and EAST of Longitude 73° 43' WEST. Steer on southeasterly course until one-half of load has been discharged, when course may be reversed to complete the discharge; return course to be parallel to but not closer than one-half mile to original course. Steam at greatest practicable speed during discharge. Under adverse weather conditions, the above course may be altered as required. In any case, complete discharge is to be accomplished SOUTH and EAST of the point of origin."

TABLE A-1

LIST OF SEWAGE TREATMENT FACILITIES DISPOSING OF SLUDGE IN NEW YORK BIGHT

Source-Treatment Plant	Ave.Daily Flow-MGD	Type of Treatment	Date of Construction
New Jersey			
Linden - Roselle	10.2	Primary	1952
Elizabeth Port	54.4	Primary	1958/
Passaic Valley	200.0	Primary	1937
Middlesex County	50.0	Primary	1958
New York			
Bowery Bay (Queens)	99.8	Secondary (Ac.Sl.)	1958/
26th Ward (Brooklyn)	52.4	Secondary (Ac.Sl.)	1951
Coney Island (Brooklyn)	76.4	Secondary (Ac.Sl.)	1962/
Wards Island (East River)	214.4	Secondary (Ac.Sl.)	1948/
Tallman Island (Queens)	37.6	Secondary (Ac.Sl.)	1963
Glen Cove (Nassau Co.)	2.7	Secondary (Tr.Ftr.)	1956
Jamaica (Queens)	71.3	Secondary (Ac.Sl.)	1963/
Rockaway (Queens)	14.4	Secondary (Ac.Sl.)	1961/
Hunts Point (Bronx)	130.3	Secondary (Ac.Sl.)	1963/
Rockaway Inlet (Nassau Co. #2, Pearsall-Hassock)	47.8	Secondary (Ac.Sl.)	1962
Yonkers Joint Meetings (Westchester Co.)	61.0	Primary	1960/
Port Richmond (Richmond Co.)	6.7	Primary	1953
Owls Head (Brooklyn)	97.8	Intermediate (Ac.Sl.)	1952
Newtown Creek (Brooklyn)	310	Secondary (Ac.Sl.)	1967

TABLE A-2

SEWAGE SLUDGE DUMPED IN THE NEW YORK BIGHT FOR 12 MONTH PERIOD

Obtained from New York District Office of U.S. Army Engineers

Month 1964	Quantities of Sludge in Cubic Yards						
	Linden-Roselle	Elizabeth Port	Passaic Valley	Middlesex County	Bowery Bay	26th Ward	Coney Island
Nov.	7,800	6,480	26,640	29,880	23,432		22,264
Dec.	14,280	15,600	39,000	31,200	17,360		26,312
1965							
Jan.	7,800	15,600	46,800	35,100	14,880	10,120	22,264
Feb.	15,600	7,800	31,200		11,544	10,120	18,216
Mar.	7,800	15,600	54,600	31,200	17,360	14,168	24,288
Apr.	7,800	19,500	54,600	27,300	11,944	8,096	24,288
May	7,800	15,600	70,200	39,000	18,472		24,288
June	7,800	15,600	78,000	39,000	16,448		28,336
July	7,800	7,800	70,200	19,500	24,800	14,168	18,216
Aug.	7,800	15,600	70,200	39,000	29,760	2,024	20,240
Sept.	7,800	7,800	62,400	39,000	12,400		28,336
Oct.	7,800	7,800	62,400	54,600	19,840	4,048	24,288
PLANT TOTALS	107,880	150,780	666,240	384,780	218,240	62,744	281,336

Grand Total 3,965,876 cu.yd. = 10,865 cu.yd. per day

Note: Newtown Creek plant will contribute an additional 1,800 cu.yd. per day.

Table A-2 Cont'd.

Month 1964	Quantities of Sludge in Cubic Yards						
	Wards Island	Talmans Island	Glen Cove	Jamaica	Rockaway	Hunts Point	Rockaway Inlet
Nov.	92,360	8,552		4,048	2,024		21,000
Dec.	74,400	12,400		26,112	4,960	17,360	3,000
1965							
Jan.	76,880	2,440		16,448	2,024	14,880	18,000
Feb.	66,690	4,960		13,568	4,960	16,904	15,000
Mar.	82,952	7,440	6,480	21,408	2,480	12,400	24,000
Apr.	81,584	6,984	3,240	4,048	2,024	14,880	10,500
May	88,968	12,600		6,528	4,048	20,496	27,000
June	96,464	19,840		13,512	9,008	2,480	12,000
July	96,264	32,240			2,480	24,800	22,500
Aug.	88,368	9,920			2,480	39,680	13,500
Sept.	85,432	9,920	3,240		4,960	49,600	30,000
Oct.	91,760	9,920			2,480	32,240	19,500
	1,022,122	137,216	12,960	105,672	43,928	245,720	216,000

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Table A-2 Cont'd.

Month 1964	Quantities of Sludge in Cubic Yards			
	Yonkers Joint Meeting	Port Richmond	Owls Head	Monthly Totals
Nov.	4,800		20,336	277,616
Dec.	6,400		22,264	310,648
1965				
Jan.	4,800		12,144	300,180
Feb.	4,740		10,120	231,422
Mar.	4,800		14,168	341,144
Apr.	7,110	4,960	14,624	303,482
May	4,740	4,048	20,240	364,028
June	3,200	6,528	18,672	366,888
July	4,740		18,472	363,980
Aug.	4,740		18,472	361,784
Sept.			25,912	366,800
Oct.	4,740	2,480	34,008	377,904
	54,810	18,016	237,432	3,965,876

TABLE A-3

WATER QUALITY BACTERIOLOGICAL RESULTS FROM THE NEW YORK BIGHT SEWAGE SLUDGE DUMP INVESTIGATION -- MAY 1966

Station	Date 1966	Time EDST	Depth	Coliform MPN per 100 ml		Remarks
	May			Total	Fecal	
1	2	1100	S*	<30	<30	
			M**	<3	<3	
			B***	240	23	
3	2	1145	S	<30	<30	Sewage sludge tanker in area.
			M	3.6	[illegible]	
			B	23	3.6	
	3	1105	S	3.6	<3	
			M	93	9.1	
			B	>2,400	240	
5	2	1220	S	11,000	750	Sewage sludge tanker in area.
			M	9.1	3.6	
			B	23	<3	
	3	1125	S	>2,400	>2,400	Sewage sludge tanker in area.
			M	1,100	43	
			B	>2,400	21	
7	2	1255	S	<30	<30	
			M	<3	<3	
			B	3.6	<3	
	3	1140	S	460	23	
			M	3.6	<3	
			B	93	<3	
9	2	1310	S	<3	<3	
			M	<3	<3	
			B	3.6	<3	
	3	1200	S	23	3.6	
			M	<3	<3	
			B	<3	<3	
11	2	1335	S	<3	<3	Acid dump area
			M	<3	<3	
			B	<3	<3	Yellow-green color
	3	1230	S	15	3.6	
			M	<3	<3	
			B	9.1	9.1	

*Surface
**Mid
***Bottom

Table A-3 Cont'd.

Station	Date 1966 May	Time EDST	Depth	Coliform MPN per 100 ml Total	Coliform MPN per 100 ml Fecal	Remarks
13	2	1355	S	<3	<3	Acid dump area
			M	<3	<3	Yellow-green color
			B	7.3	7.3	
	3	1250	S	9.1	<3	
			M	3.6	<3	
			B	<3	<3	
15	2	1440	S	<3	<3	
			M	<3	<3	
			B	3.6	<3	
	3	1310	S	3.6	<3	
			M	<3	<3	
			B	3.6	<3	
17	2	1510	S	<3	<3	
			M	7.3	<3	
			B	<3	<3	
	3	1330	S	<3	<3	
			M	<3	<3	
			B	<3	<3	
19	5	1030	S	9.1	<3	
			M	<3	<3	
			B	23	3.6	
	6	1055	S	<3	<3	Sewage sludge tanker in area
			M	460	9.1	
			B	>2,400	93	
20	5	1012	S	3.6	<3	
			M	<3	<3	
			B	9.1	<3	
	6	1040	S	150	20	
			M	3.6	<3	
			B	460	15	
21	5	0950	S	3.6	<3	
			M	3.6	<3	
			B	93	23	
	6	1025	S	9.1	<3	
			M	23	<3	
			B	240	23	

Table A-3 Cont'd.

Station	Date 1966 May	Time EDST	Depth	Coliform MPN per 100 ml Total	Fecal	Remarks
22	5	0935	S	<3	<3	
			M	9.1	<3	
			B	93	23	
	6	1005	S	3.6	<3	
			M	43	9.1	
			B	240	23	
23	5	1312	S	3.6	<3	
			M	3.6	<3	
			B	15	7.3	
	6	1115	S	<3	<3	
			M	93	9.1	
			B	1,100	43	
24	5	1335	S	3.6	<3	
			M	3.6	3.6	
			B	9.1	<3	
	6	1125	S	43	<3	
			M	3.6	<3	
			B	1,100	93	
25	5	1350	S	<3	<3	
			M	23	<3	
			B	9.1	<3	
	6	1140	S	23	3.6	
			M	3.6	<3	
			B	210	43	
26	5	1405	S	9.1	<3	
			M	<3	<3	
			B	43	<3	
	6	1150	S	150	20	
			M	3.6	<3	
			B	460	15	
27	6	1205	S	43	<3	
			M	43	3.6	
			B	23	9.1	
28	6	1220	S	460	<3	
			M	43	3.6	
			B	9.1	<3	

Table A-3 Cont'd.

Station	Date 1966 May	Time EDST	Depth	Coliform MPN per 100 ml Total	Fecal	Remarks
29	7	0935	S	3.6	<3	
			M	23	<3	
			B	93	3.6	
	8	0835	S	23	<3	
			M	23	<3	
			B	9.1	3.6	
30	7	0950	S	3.6	<3	
			M	23	<3	
			B	23	<3	
	8	0850	S	43	9.1	
			M	43	3.6	
			B	23	9.1	
31	7	1003	S	<3	<3	
			M	<3	<3	
			B	460	<3	
	8	0905	S	43	23	
			M	43	3.6	
			B	43	3.6	
32	7	1020	S	43	7.3	
			M	43	<3	
			B	43	43	
	8	0917	S	23	<3	
			M	43	9.1	
			B	>2,400	150	
33	7	1033	S	93	7.3	
			M	43	7.3	
			B	93	23	
	8	0930	S	43	9.1	
			M	23	3.6	
			B	>2,400	210	
34	7	1057	S	23	3.6	Sludge dump slick in area.
			M	9.1	9.1	
			B	>2,400	240	
	8	0950	S	23	3.6	
			M	21	<3	
			B	3.6	<3	

Table A-3 Cont'd.

Station	Date May 1966	Time EDST	Depth	Coliform MPN per 100 ml Total	Fecal	Remarks
35	7	1105	S	210	21	Sludge dump slick in area.
			M	9.1	3.6	
			B	240	9.1	
	8	1005	S	9.1	<3	
			M	7.3	7.3	
			B	<3	<3	
36	7	1110	S	93	3.6	
			M	9.1	<3	
			B	93	<3	
	8	1013	S	3.6	<3	
			M	3.6	3.6	
			B	3.6	3.6	
37	7	1136	S	75	<3	
			M	<3	<3	
			B	<3	<3	
	8	1028	S	3.6	3.6	
			M	3	3	
			B	3.6	3.6	
38	7	1150	S	9.1	<3	
			M	<3	<3	
			B	9.1	<3	
	8	1041	S	3.6	3.6	
			M	<3	<3	
			B	<3	<3	

TABLE A-4

DUPLICATE COLIFORM MPN TESTING OF SAMPLE WITH A PORTION SETUP IMMEDIATELY -- THE REMAINDER BEING ICED AND SETUP AFTER COMPLETION OF DAYS SAMPLING

Station	Date May 1966	Total Coliform MPN per 100 ml		Fecal Coliform MPN per 100 ml	
		Boat	Lab.	Boat	Lab.
19	5	<3	9.1	<3	<3
	6	3.6	<3	<3	<3
20	5	3.6	3.6	<3	<3
	6	3.6	<3	<3	<3
21	5	3.6	3.6	<3	<3
	6	15	9.1	<3	<3
22	5	3.6	<3	<3	<3
	6	3.6	3.6	<3	<3
23	5	3.6	3.6	<3	<3
		3.6	<3	<3	<3
24	5	9.1	3.6	<3	<3
	6	9.1	43	3.6	<3
25	5	<3	<3	<3	<3
	6	150	23	3.6	3.6
26	5	14	9.1	<3	<3
	6	43	150	3.6	20
27	6	43	43	15	<3
28	6	23	460	9.1	<3
29	7	15	3.6	<3	<3
30	7	<3	3.6	<3	<3
31	7	3.6	<3	<3	<3
32	7	9.1	43	<3	7.3
33	7	150	93	15	7.3
34	7	3.6	23	<3	3.6
35	7	43	210	15	21
36	7	240	93	23	3.6
37	7	43	75	9.1	<3
38	7	3.6	9.1	<3	<3

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TABLE A-5

HYDROGRAPHIC DATA -- NEW YORK BIGHT

Sta.	Date 1966 May	Time EDST	Sample Positions	Bottom Depth (ft.)	Temp. °C	Salinity ‰	Wind Velocity (knots)	Wind Direction
1	2	1100	S*	78	7.3	30.4	9	NE
			M**		6.2	30.4		
			B***		6.0	30.6		
3	2	1145	S	96	7.3	30.3	3	NE
			M		5.9	30.7		
			B		5.9	30.6		
	3	1105	S		8.0	28.7	10	SW
			M		6.4	29.9		
			B		6.0	29.9		
5	2	1220	S	100	7.0	30.3	1	NE
			M		6.0	30.6		
			B		5.9	30.6		
	3	1125	S		8.3	28.9	10	SW
			M		6.2	30.0		
			B		6.0	30.0		
7	2	1255	S	114	7.2	30.4	1	NE
			M		6.0	30.5		
			B		6.0	30.9		
	3	1140	S		7.6	29.4	18	SE
			M		5.9	30.4		
			B		5.8	30.3		
9	2	1310	S	123	7.5	30.4	1	NE
			M		6.7	30.5		
			B		5.6	30.6		
	3	1200	S		7.9	29.1	18	SE
			M		6.0	29.9		
			B		5.7	30.2		
11	2	1335	S	150	7.9	30.4	1	NE
			M		5.8	30.4		
			B		5.5	30.5		
	3	1230	S		7.9	29.5	18	S
			M		5.9	30.4		
			B		5.5	30.2		

*Surface
**Mid
***Bottom

Table A-5 Cont'd.

Sta.	Date 1966 May	Time EDST	Sample Positions	Bottom Depth (ft.)	Temp. °C	Salinity °/oo	Wind Velocity (knots)	Wind Direction
13	2	1355	S	168	7.3	30.3	0	
			M		5.9	30.6		
			B		5.3	31.0		
	3	1250	S		8.0	29.1	10	S
			M		6.0	30.2		
			B		5.6	30.3		
15	2	1440	S	153	7.4	30.5	0	
			M		5.8	30.1		
			B		5.4	31.0		
	3	1310	S		7.8	29.2	18	S
			M		5.9	29.7		
			B		5.5	29.8		
17	2	1510	S	104	6.8	30.5	0	
			M		5.8	29.8		
			B		5.7	29.9		
	3	1330	S		7.8	29.3	20	S
			M		5.9	29.9		
			B		5.7	30.1		
19	5	1030	S	95	7.8	28.1	14	SE
			M		6.2	29.6		
			B		5.9	29.6		
	6	1055	S		7.5	26.9	17	SSW
			M		6.4	28.5		
			B		6.2	28.9		
20	5	1012	S	90	7.7	28.7	11	SE
			M		7.3	29.1		
			B		5.8	29.7		
	6	1040	S		7.8	27.2	15	SSW
			M		6.9	28.3		
			B		6.4	28.5		
21	5	0950	S	80	7.5	29.0	14	SE
			M		7.5	29.0		
			B		5.8	29.8		
	6	1025	S		7.7	27.0	12	SSW
			M		7.0	28.2		
			B		6.7	28.5		

Table A-5 Cont'd.

Sta.	Date 1966 May	Time EDST	Sample Positions	Bottom Depth (ft.)	Temp. °C	Salinity ‰	Wind Velocity (knots)	Wind Direction
22	5	0935	S	72	7.4	29.0	13	SSE
			M		7.0	29.2		
			B		6.0	29.9		
	6	1005	S		7.9	26.6	12	SSW
			M		7.0	26.8		
			B		6.8	28.1		
23	5	1312	S	96	8.0	27.9	25	S
			M		6.2	29.1		
			B		6.0	29.9		
	6	1115	S		7.8	27.4	15	SSW
			M		6.7	28.6		
			B		6.2	29.2		
24	5	1335	S	90	8.0	27.7	28	SW
			M		6.1	29.1		
			B		5.9	29.6		
	6	1125	S		8.2	27.0	15	SSW
			M		6.7	28.5		
			B		6.1	29.2		
25	5	1350	S	90	8.0	27.4	28	SW
			M		6.0	28.2		
			B		6.0	29.4		
	6	1140	S		8.4	26.3	15	SSW
			M		6.8	28.2		
			B		6.1	29.3		
26	5	1405	S	90	7.7	27.3	28	SW
			M		6.3	29.0		
			B		5.6	29.4		
	6	1150	S		8.4	27.1	15	SSW
			M		6.2	27.6		
			B		6.1	29.1		
27	6	1205	S	82	8.9	25.7	13	SW
			M		6.3	28.7		
			B		6.0	29.0		
28	6	1220	S	73	7.5	25.9	13	SW
			M		6.6	28.6		
			B		5.9	29.0		

Table A-5 Cont'd.

Sta.	Date 1966 May	Time EDST	Sample Positions	Bottom Depth (ft.)	Temp. °C	Salinity ‰	Wind Velocity (knots)	Wind Direction
29	7	0935	S	72	7.8	27.3	16	NW
			M		6.2	28.9		
			B		6.1	29.4		
	8	0835	S		7.2	27.9	15	SE
			M		6.3	29.0		
			B		6.0	29.3		
30	7	0950	S	78	7.7	27.9	15	NW
			M		6.2	29.4		
			B		6.0	29.5		
	8	0850	S		7.5	27.4	15	S
			M		6.5	29.4		
			B		5.9	29.6		
31	7	1003	S	90	7.3	28.0	18	NW
			M		6.2	29.4		
			B		5.8	29.9		
	8	0905	S		7.8	26.9	18	SSW
			M		6.3	29.2		
			B		5.9	29.4		
32	7	1020	S	90	7.7	28.2	18	NW
			M		6.1	29.4		
			B		6.0	29.7		
	8	0917	S		8.2	26.7	15	SW
			M		5.8	29.5		
			B		5.8	29.6		
33	7	1033	S	90	7.5	28.5	18	NW
			M		6.4	29.2		
			B		6.0	29.7		
	8	0930	S		8.1	27.4	15	SW
			M		7.3	28.5		
			B		5.6	29.7		
34	7	1057	S	100	7.5	28.6	18	NW
			M		6.3	29.4		
			B		6.0	29.7		
	8	0950	S		7.8	27.8	12	SW
			M		7.3	28.7		
			B		5.8	29.8		

Table A-5 Cont'd.

Sta.	Date 1966 May	Time EDST	Sample Positions	Bottom Depth (ft.)	Temp. °C	Salinity ‰	Wind Velocity (knots)	Wind Direction
35	7	1105	S	105	7.5	28.4	18	NW
			M		6.4	29.4		
			B		6.0	29.6		
	8	1005	S		7.7	27.9	5	SW
			M		7.0	28.5		
			B		5.8	29.8		
36	7	1110	S	120	8.0	28.1	7	NW
			M		6.0	29.8		
			B		5.8	29.9		
	8	1013	S		7.6	28.0	5	SW
			M		7.0	28.4		
			B		5.8	29.8		
37	7	1136	S	105	7.9	28.0	7	NW
			M		6.0	29.7		
			B		5.8	29.9		
	8	1028	S		8.0	28.1	5	SW
			M		7.6	28.1		
			B		5.7	29.6		
38	7	1150	S	93	8.0	27.6	5	NW
			M		6.6	28.8		
			B		5.8	29.9		
	8	1041	S		8.1	27.7	2	SW
			M		6.3	29.0		
			B		5.8	29.7		

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